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How Soon Will The U.S. Reach Full Employment? An Assessment Based On Okun's Law

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This paper re-examines the relation between unemployment and real economic growth and develops estimates of the unemployment rate under a variety of economic "scenarios" for the 1990s. The empirical results suggest that if real GNP grows at an annual rate of four percent, the growth rate projected by the Reagan Administration, the unemployment rate will decline to six percent by 1990. The unexpectedly rapid decline in unemployment since 1982 appears to reflect the strong cyclical upturn in the economy rather than any change in the historical relation between the jobless rate and GNP.

In the first year and a half of recovery from the 1981-82 recession, during which the unemployment rate rose to its highest level in more than forty years, the number of jobless workers has declined dramatically. By June 1984, the civilian unemployment rate had fallen to 7.1 percent from its peak of 10.8 percent reached in December 1982. This improvement in labor market conditions has been greater than most economists expected. In its 1984 *Annual Report*, for example, the President's Council of Economic Advisers projected that the jobless rate would not fall below 7 percent until 1987.

The analysis of this paper suggests that this unexpectedly rapid decline in unemployment resulted largely from the fact that the cyclical upswing in real GNP has been much stronger than anticipated. In the first half of 1984, real GNP rose at an extraordinarily high annual rate of 8.8 percent. Most forecasters expect GNP growth in the second half of the year and in 1985 to be considerably slower. Hence, future declines in the jobless rate are likely to come more slowly.

The purpose of this paper is to examine the relation between unemployment and economic growth with a view to developing longer run projections of the unemployment rate out to 1990. The framework used is one originally developed by Arthur Okun in 1962 and popularly known as *Okun's Law*. Okun found that there was a stable relation between changes in the rate of real economic growth and changes in the unemployment rate. In this paper, Okun's estimates of this relation are updated and used to make projections of the unemployment rate. Various alternative assumptions regarding the rate of real economic growth between 1983 and 1990 are used. A distinctive feature of these projections is that the impact on unemployment of *long-run* swings in the growth rate of output is analyzed in addition to the effect of cyclical fluctuations. Most previous studies, including Okun's own analysis, have focused on the short-run relation between output

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growth and unemployment over the business cycle.

The object of this paper is not to develop unconditional *forecasts* of the unemployment rate, but rather to examine the implications for labor market conditions of alternative "scenarios" for real economic growth in the years ahead. This more modest objective is useful for two closely related reasons. First, since policies that aim to hasten real growth run the risk that they will overstimulate the economy and add to the rate of inflation, it is valuable to gauge the likely benefits of such policies in the form of reduced unemployment. Second, and conversely, because the likelihood of faster inflation tends to increase as the economy approaches high levels of employment, it is useful to attempt to make judgments of how rapidly alternative paths of real growth will lower the unemployment rate and thus of how soon they will bring the economy to its inflation threshold.

I. Okun's Law

After examining the statistical relation between the unemployment rate and real GNP, Arthur Okun summarized his findings in the following statement,[1] which later became known as Okun's Law.

> *In the postwar period, on the average, each extra percentage point in the unemployment rate above four percent has been associated with about a three percent decrement in real GNP.*

In this statement of his "Law", Okun took it for granted that "full employment" corresponded to a measured unemployment rate of four percent. Since Okun wrote his classic paper, economists' views of what constitutes full employment have changed significantly. Now, the Law is more often expressed as a relation between the growth rate of real GNP and changes in the unemployment rate.

To maintain a constant unemployment rate, real output must grow at a rate sufficient both to offset increases in output per worker and to provide jobs for new entrants to the labor force. If real GNP grows more slowly than this "required" rate, unemployment will rise; joblessness will decline if real growth exceeds the required rate. In particular, Okun's Law states that if the annual growth rate of real GNP is increased by three percentage points, with no change in the "required" rate, the unemployment rate will decline by one percentage point each year. That an increase in the growth rate of real GNP is associated with a less than proportionate reduction in the unemployment rate is explained by the fact that more rapid real growth also tends to be associated with increasing labor force participation and more rapid growth in output per employed worker. Increased participation in the labor force and higher labor productivity (output per worker) in turn mean that a given increase in real output requires a smaller increase in the proportion of the labor force employed and hence a smaller decrease in the proportion that is unemployed.

These growth-accounting relations may be seen more formally in the following output identity:[2]

$$Y/P = (Y/E) \times (E/L) \times (L/P) \qquad (1)$$

where Y = Real Output
P = Adult Population
E = Civilian Employment
L = Civilian Labor Force

This identity shows that output per head of the adult population, Y/P, may be decomposed into output per employed worker, Y/E, employment as a proportion of the labor force, E/L, and the labor force as a proportion of the population, L/P. Using the symbols y, q, e and p to represent these four ratios, Equation (1) may be rewritten as:

$$y = q \times e \times p \qquad (2)$$

Taking logarithms of this equation, differentiating with respect to time, and rearranging terms, yields an expression for the growth rate[3] of the employment rate, e, in terms of the growth rates of the other three variables:

$$d\ln e = d\ln y - d\ln q - d\ln p \qquad (3)$$

Since the employment rate, e, is simply the converse of the unemployment rate, u, so that $e = (1-u)$, and since $\ln(1-u)$ is approximately[4] equal to -u, this equation in turn may be written:

$$-du = d\ln y - (d\ln q + d\ln p) \qquad (4)$$

Equations (3) and (4) are *accounting* relations with no particular economic content. Okun's Law, by contrast, states that there is a *behavioral* relation between the growth rate of real GNP and the change in the unemployment rate. This hypothesis may be written:

$$du = a' + b' \, dln \, y + v' \quad (5)$$

where a′ and b′ are parameters and v′ represents a random error term.

Okun's finding that a one point reduction in the unemployment rate required a three percentage point increase in real GNP growth meant that b′ in Equation (5) was approximately one-third. This result also implied that the growth rates on the right side of Equation (4) are not independent of one another. Since a *three* percentage point increase in the growth rate of output is associated with only a *one* point reduction in the unemployment rate, the combined growth rates of labor productivity and labor force participation, dln q + dln p, must rise by *two* percentage points.

Although Okun's Law normally is stated in terms of changes in the unemployment rate, the analysis and empirical computations in this paper are conducted in terms of employment in order to make use of the *exact* accounting relationship embodied in Equation (3) rather than its approximation in Equation (4). In terms of the employment rate, Okun's Law is written:

$$dln \, e = a + b \, dln \, y + v \quad (6)$$

Notice that Equation (6) implies that in order to hold the employment rate *constant*, real GNP must grow at a rate -a/b. Hence, we expect empirical estimates of Equation (6) to yield a negative intercept term.

By substituting Equation (6) into Equation (3) and re-arranging terms, we obtain:

$$dln \, q + dln \, p = -a + (1-b) \, dln \, y - v \quad (7)$$

This equation shows that if there is a stable relation between the growth rates of real GNP and the employment rate (Okun's Law), then there also is a stable relation between the growth rate of real GNP and the *sum* of the growth rates of labor productivity and labor force participation. This does not, however, necessarily mean that the growth rates of labor productivity and labor force participation are *each* related in a stable way to real output.

Indeed, it is not hard to think of reasons that the relations of both labor force participation and labor productivity to real GNP might be quite unstable even though the relation of the sum of their growth rates to output growth is a close and stable one. Suppose, for example, that, for demographic or cultural reasons, the growth of labor force participation increases. This means both that there is an increase in the total supply of labor and that a larger proportion of the total work force consists of less experienced workers. Firms will be encouraged both to adopt more labor-intensive methods of producing their existing products and to switch to product lines that require more labor and less capital. The result of these changes is likely to be a slowing in the growth rate of labor productivity.[5] Conversely, suppose there is an exogenous shock to the economy—such as a rise in the price of energy—that slows the growth of labor productivity and, hence, of real wages. Such a shock is likely to cause an increase in labor force participation as families seek to maintain their living standards.

These informal arguments suggest that more rapid labor force growth is likely to lead to a slowing in productivity growth, and also, conversely, that a decline in productivity growth may cause a rise in labor force participation. Whatever the actual cause and effect relationship between the growth rates of labor productivity and of participation in the work force, it is striking that the slowing in the growth of output per worker after 1965 roughly coincided with the acceleration in labor force participation. The effect of these opposing movements in the growth rates of participation and of productivity is that the *sum* of their growth rates is more stable over time

Chart 1
Employment Rate

than is either individual growth rate. This provides a reason for expecting that Okun's law will remain stable even in the face of changes in the growth of participation and productivity. In effect, the Law *internalizes* the tendency for productivity growth and participation to vary inversely. In Charts 1-3 we show the paths of these key ratios over the 1951-83 period.

The Stability of Okun's Law

To use a simple Okun's Law equation such as Equation (6) to estimate the implications for the employment rate of some postulated path for future real output, it is necessary to assume that the parameters of the equation remain constant over the prediction period. Clearly, the stability of these parameters in the *past* will be a valuable indication of the reasonableness of this assumption.

Tests of the stability of Okun's Law were performed using quarterly data over the 33-year period, 1951–1983. To allow for lags of adjustment, the current and two lagged values of the quarterly GNP growth rate were used as regressors. Equations were estimated in the form:

$$\text{dln } e_t = a_0 + a_1 \text{ dln } y_t + a_2 \text{ dln } y_{t-1} + a_3 \text{ dln } y_{t-2} + v_t \quad (8)$$

The test procedure used was one devised by Quandt.[6] This test proceeds in two stages. First, the technique provides a method of finding the date at which any parameter change is most likely to have occurred. It does this by finding the date at which the overall fit of the equation can be most improved by splitting the sample. Second, having located this "switching point", it tests whether there was in fact a statistically significant parameter shift at that date.[7]

Table 1 summarizes the results of these stability tests. Since the first stage of the testing procedure indicated that the most probable switching point was the second quarter of 1966, Sample I refers to the period 1951(I) – 1983(IV), while Samples II and III are the sub-samples of this period, 1951(I) – 1966(I) and 1966(II) – 1983(IV). The first three columns show the results of estimating Equation (8) over these three sample periods with no restrictions. The F-statistic shown in the first column tests the hypothesis that all the coefficients remained constant over the full sample period—this hypothesis cannot be rejected. Columns four and five give the estimated coefficients when the intercept is permitted to change but the "slope" coefficients are constrained to be constant between the two sample periods. The F-statistic in column four tests the hypothesis that the intercept did not change between the two periods—this hypothesis is rejected. Finally, columns six and seven show the coefficients when the intercept is constrained to be constant and the slopes are allowed to vary. The F-statistics in column six test the hypothesis that the slope coefficients did not change between the subperiods, first under the assumption that the intercept was constant, and, second, assuming that the intercept

Chart 2
GNP per Employed Worker

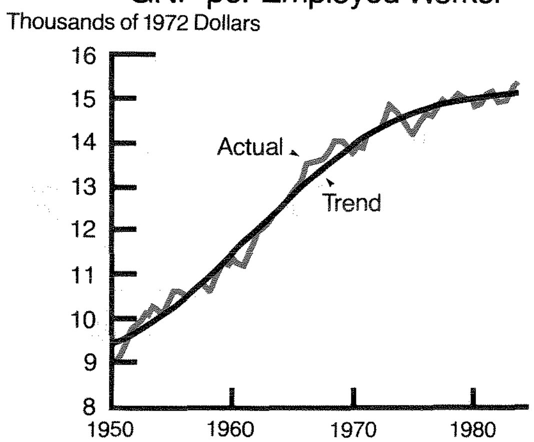
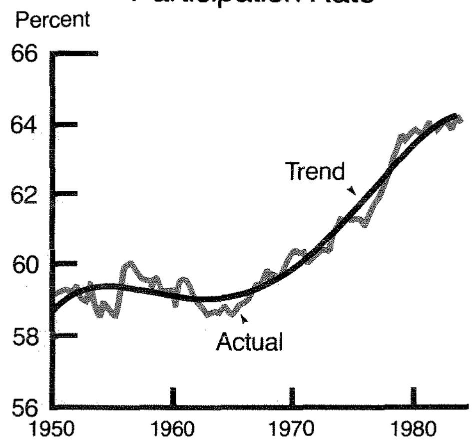


Chart 3
Participation Rate



shifted in 1966(II). Under either assumption, the hypothesis that the slope coefficients remained constant cannot be rejected.

The principal conclusion from this series of tests is that we can accept the hypothesis that changes in the employment rate were related in a stable way to changes in the growth rate of real GNP over the 1951-83 period. That is, the slope coefficients in Equation (8) remained constant. Thus, the analysis of twenty years of additional data does not alter Okun's basic conclusion that there is a stable relation between short-run changes in real GNP and the unemployment rate. The stability of this relation over the last thirty years provides a strong basis for continuing to use it for prediction prupose.

Assuming that the intercept did shift between the two sample periods, the sum of the slope coefficients in the estimated equation[8] is 0.481. This value implies that to raise the annual growth rate of the employment rate by one percentage point required an increase in the annual growth rate of real per capita GNP of 2.08 percentage points. This compares to Okun's estimate of three percentage points over the 1947–1960 period.

The statistically significant rise in the intercept term in the estimated equation implies that the growth rate of real GNP required to keep the employment rate unchanged did not remain constant over the full 1951-1983 sample period. As shown earlier in connection with Equation (6), this required growth rate is the negative of the ratio of the intercept to the slope, so that the finding that the intercept has become less negative implies that it has required a *lower* growth rate of real GNP to hold the employment rate constant since 1966.

The required growth rate, computed by dividing the negative of the estimated intercept by the sum of the slope coefficients, is shown at the bottom of Table 1. These computations indicate that an annual growth rate in *per capita* GNP of 1.51 percent was needed to hold the unemployment rate constant over the period between 1966 and 1983, whereas the required rate in the earlier sample period was 2.39 percent. The adult population increased at an annual rate of 1.77 percent between 1966 and 1983, implying a required annual growth rate of *total* GNP of 3.28 percent. In fact, GNP rose at an average rate of only 2.67 percent per year over this period and, as a

Table 1
Okun's Law: Stability Tests
(Dependent Variable is Annual Growth Rate of Employment Rate)

	Sample I	Sample II	Sample III	Sample II	Sample III	Sample II	Sample III
Constant	-0.898	-1.148	-0.722	-1.152	-0.726	-0.883	-0.883
	(9.28)	(7.39)	(5.96)	(8.18)	(6.15)	(9.11)	(9.11)
Per Capita GNP (t)	0.249	0.234	0.263	0.255	0.255	0.217	0.268
	(11.13)	(6.79)	(8.99)	(11.55)	(11.55)	(6.38)	(9.07)
Per Capita GNP (t-1)	0.166	0.218	0.141	0.169	0.169	0.213	0.146
	(6.90)	(5.62)	(4.67)	(7.17)	(7.17)	(5.40)	(4.75)
Per Capita GNP (t-2)	0.052	0.028	0.073	0.057	0.057	0.012	0.078
	(2.36)	(0.84)	(2.52)	(2.66)	(2.66)	(0.371)	(2.69)
F-statistic	2.14			5.96**		1.26 0.87	
"Required" Growth Rate*	1.93	2.39	1.51	2.39	1.51	2.00	1.79

*Growth rate of per capita GNP required to hold the unemployment rate constant.
**Statistically significant at the 5 percent level.

consequence, the unemployment rate increased from 3.8 percent to 8.5 percent. To bring the unemployment rate *down*, real output growth must proceed *faster* than the required rate.

Okun's Law and the Business Cycle

The fact that Okun stated his Law in terms of deviations from full employment suggests that he regarded it as applying primarily to *cyclical* variations in output and employment. Over the business cycle, the output growth rate required to compensate for long-run movements in output per worker and in labor force participation, and so to hold the unemployment rate steady, would not change much. As a result, the intercept term in a simple Okun's Law equation would remain approximately constant. However, the results in Table 1 indicate that this required growth rate may change in the long-run. To develop an explicit expression for the required rate, assume that real output and the employment rate each may be written as the product of a trend component and a cyclical component. In terms of growth rates, this assumption implies:

$$\text{dln } y_t = \text{dln } y_{T,t} + \text{dln } y_{C,t} \qquad (9)$$

$$\text{dln } e_t = \text{dln } e_{T,t} + \text{dln } e_{C,t} \qquad (10)$$

Now assume that the growth rate of the *cyclical* component of the employment rate is related to *cyclical* changes in real output.

$$\text{dln } e_{C,t} = B \text{ dln } y_{C,t} + w_t \qquad (11)$$

where w_t represents a random error term. Combining Equations (9), (10) and (11) yields an Okun's Law equation in terms of both the original variables and their *trend* components:

$$\text{dln } e_t = (\text{dln } e_{T,t} - B \text{ dln } y_{T,t}) + B \text{ dln } y_t + w_t \qquad (12)$$

This equation is analogous to Equation (6) except that the intercept term in parentheses is not necessarily constant. Hence, the hypothesis that there is a stable relation between output and employment *over the business cycle* is consistent with the empirical results in Table 1 since that hypothesis does not require that the intercept term of the estimated equation be a constant. In particular, by setting the left side of Equation (12) equal to zero, it may be solved for the output growth rate required to hold the employment rate steady:

$$\text{dln } y_t^R = \text{dln } y_{T,t} - \text{dln } e_{T,t}/B \qquad (13)$$

Hence, Equation (12) may also be written as

$$\text{dln } e_t = B(\text{dln } y_t - \text{dln } y_t^R) + w_t \qquad (14)$$

which again shows that shifts in the estimated intercept of an Okun's Law equation may be interpreted as representing changes in the rate of output growth required to hold the employment rate steady.

Since the objective of this paper is to examine the implications of alternative GNP scenarios rather than to develop unconditional forecasts of the unemployment rate, no attempt is made explicitly to model changes in the required output growth rate. This would require a detailed analysis of future trends of productivity and labor force participation. Instead, I have assumed in making the projections that the trend in the employment rate varies with changes in the trend of output. Equations (13) and (14) show that this assumption implies that the required output growth rate—and hence the intercept of the Okun's Law equation—also varies with the trend in real GNP.

Alternative Techniques for Predicting Unemployment

The use of Okun's Law is not the only technique available for predicting the future unemployment rate. For example, most economists argue that in the long-run the unemployment rate will approach what is known as the *natural rate*. Hence, the best *long-run* forecast of the unemployment rate is that it will be equal to the natural rate.

Even when the economy is operating at a high level of activity, persons are continually entering and leaving the unemployment pool. New entrants to the labor force generally find they must devote a period of time to searching for a job before locating one. Similarly, at any particular time, a number of established workers will be unemployed as they go through the normal process of moving between jobs. Because each individual worker and each job is to some extent unique, and because neither job-seekers nor potential employers have complete information, it takes time for these unemployed persons to find jobs. This normal amount of joblessness, which occurs even when labor markets are in equilibrium so that there is no tendency for nominal wages either to accelerate or to decelerate, is termed the "*natural rate*" of unemployment by economists.

The total number of persons unemployed depends on the number *becoming* unemployed each month and on the *average time* taken by each to search for a suitable job.[9] For example, if 100 persons become newly unemployed each month and the average search time is six months, the average number of unemployed will be 600 persons. The average time spent looking for a job depends on the costs of and returns to job-search. Factors which increase the costs of search—for example, a reduction in unemployment compensation benefits—or which make search more effective—such as the development of employment agencies—shorten average search times and so cause the natural rate to decline. On the other hand, an increase in the average flow of persons into the unemployment pool will tend to raise the natural rate. Such an increase might be caused, for example, by more rapid technological change or more frequent changes in the pattern of final demand which would make it necessary for workers to change jobs more often. Thus, the natural rate of unemployment will tend to be higher in a dynamic, changing economy than in a more stable one. Demographic changes also may affect the natural rate by increasing or decreasing the average flow of new entrants into the work force.

In making the projections in this paper, I have not followed the natural rate approach largely because it requires both explicit assumptions regarding what the natural rate is and when it will be reached and an implicit assumption that actual unemployment will approach the natural rate "smoothly." Although most economists argue that the natural rate is in the vicinity of 6–7 percent, such assumptions are necessarily arbitrary. Nonetheless, it is worth pointing out that Equation (12) is quite consistent with the natural rate approach. In the very long-run, the actual and trend growth rates of real GNP will be equal. In that case, the equation implies that the actual change in the employment rate is equal to the trend change which, presumably, reflects only changes in the natural rate.

For shorter time horizons, an alternative approach to the use of Okun's Law would be to forecast separately the growth of labor productivity, Y/E, and of labor force participation, L/P, and to use Equation (1) to derive a forecast of the employment rate. This appears to be the approach used by the Council of Economic Advisers in developing its near-term projections of the unemployment rate.[10] It has the advantage of permitting explicit consideration of the wide range of factors that influence the unemployment rate through their effect on productivity or participation. But it possesses the disadvantage of not allowing for the apparent interdependence between participation and productivity changes which is internalized in Okun's Law. For example, the CEA uses estimates of future labor force participation prepared by the Bureau of Labor Statistics.[11] These estimates are based primarily on demographic rather than economic considerations.

II. Predicting the Employment Rate

For making the empirical estimates, a more detailed decomposition of real GNP was used. Equation (1) was extended to

$$Y/P = Y/(E \times H) \times E/L \times L/P \times H/HP \times HP \quad (15)$$

where H = Average Annual Hours Worked per Employed Person

HP = Potential Annual Hours per Person in the Labor Force

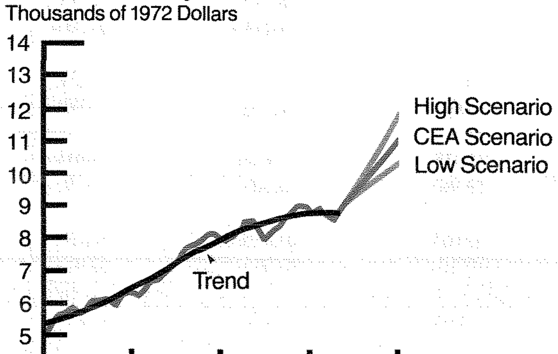
Changes in potential hours per worker chiefly reflect variations in the proportion of the labor force that chooses to work part-time. Divergences between actual and potential hours result from variations in the incidence of overtime and involuntary part-time work over the business cycle. Data on each of the components of this identity are available from the Bureau of Labor Statistics.[12]

Separate projections were developed of the trend and cyclical components both of the employment rate and of each of the "supplementary" variables in Equation (15): output per worker-hour, the participation rate, the actual/potential hours ratio and potential hours per head. As explained above, variations in the trend growth rate of employment are proxies for changes in the required output growth rate and thus for movements in the intercept of the Okun's Law equation. The projections of the supplementary variables were made to provide an informal check on the reasonableness of the employment rate estimates. As it happened, however, the "fit" of the equations explaining the supplementary variables was inferior to the Okun's Law equations, making predictions derived from them less reliable.

Three sets of projections were computed based on alternative assumptions about the behavior of real GNP per capita between now and the end of the decade.[13] The "high growth" and "low growth" scenarios call respectively for average real annual per capita growth rates of four percent and two percent between 1983(IV) and 1990(IV). The "CEA scenario" calls for growth in real per capita GNP at approximately the rates assumed in the 1984 *Report of the Council of Economic Advisers*.[14] These assumptions call for real GNP to grow at rates of 4.5 percent in 1984 and 4.0 percent in the rest of the decade. Since the adult population is expected to rise at an annual rate of roughly one percent, the CEA scenario for *per capita* growth was constructed by subtracting one percentage point from the GNP growth rates assumed by the Council.

Each series in Equation (15) was decomposed into its trend and cyclical components by regressing its logarithm on a fourth degree polynomial in time over the period 1950(I) – 1983(IV).[15] The fitted values from these regressions were designated as the trend components and the residuals as the cycle components.

Chart 4
GNP per Capita,
with Projections to 1990



Under each growth scenario, the projected level of per capita GNP in the fourth quarter of 1990 was computed by applying the assumed quarterly growth rates to its actual level in 1983(IV). It was assumed that the actual and trend levels of real GNP will be equal[16] in 1990(IV) and that the trend path will follow a fourth degree polynomial between 1983(IV) and 1990(IV).[17] Chart 4 shows these GNP projections on which the employment rate forecasts were based.

The first stage of the forecasting process consists of projecting the trends in the employment rate and each of the supplementary variables under each GNP scenario. This requires estimates of the relations between the trend component of each variable and trend GNP. To obtain these estimates, the trend and cycle components of each variable are assumed to be linearly related to GNP.

$$\text{dln } z_t^T = a^T + b_o^T \text{ dln } y_t^T + b_1^T \text{ dln } y_{t-1}^T + b_2^T \text{ dln } y_{t-2}^T + v_t^T \quad (16)$$

$$\text{dln } z_t^C = a^C + b_o^C \text{ dln } y_t^C + b_1^C \text{ dln } y_{t-1}^C + b_2^C \text{ dln } y_{t-2}^C + v_t^C \quad (17)$$

where dln z_t represents the growth rates of the employment rate and of each of the four supplementary variables, dln y_t represents the growth rate of real GNP, and the superscripts (T and C) identify the trend and cycle components of these variables.

Summing Equations (16) and (17) and rearranging terms yields:

$$\begin{aligned}\text{dln } z_t = {} & (a^T + a^C) + (b_o^T - b_o^C) \text{ dln } y_t^T \\ & + (b_1^T - b_1^C) \text{ dln } y_{t-1}^T + (b_2^T - b_2^C) \text{ dln } y_{t-2}^T \\ & + b_o^C \text{ dln } y_t + b_1^C \text{ dln } y_{t-1} \\ & + b_2^C \text{ dln } y_{t-2} + v_t^T + v_t^C\end{aligned}$$

Since trend GNP is a smooth series, these equations may be approximated by

$$\begin{aligned} \text{dln } z_t = {} & [a + ((b_0^T + b_1^T + b_2^T) - (b_0^C + b_1^C + b_2^C)) \\ & \times ((\ln y_t^T - \ln y_{t-3}^T)/3)] \qquad (18) \\ & + b_0^C \text{ dln } y_t + b_1^C \text{ dln } y_{t-1} \\ & + b_2^C \text{ dln } y_{t-2} + v_t \\ & \text{where } a = a^T + a^C \text{ and } v_t = v_t^T + v_t^C . \end{aligned}$$

In these equations, the quarterly growth rate of each variable depends on the *actual* quarterly growth rates of GNP in the last three quarters and the *average trend* growth rate over those quarters. In particular, the employment rate equation in (18) is the empirical counterpart of Equation (12). The terms in brackets represent the intercept of the Okun's Law equation and varies in response to changes in the trend GNP growth rate.

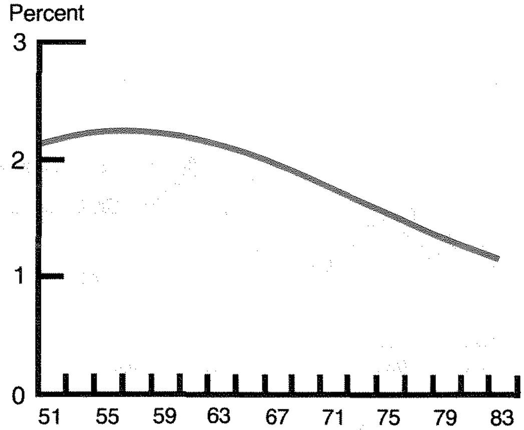
Table 2 provides estimates of the coefficients of Equations (18) under the CEA scenario. As required by the theory, the constant term and the coefficient on trend GNP growth in the employment rate equation both are statistically significant and negative, implying that the GNP growth rate required to hold the employment rate steady is positive.[18] Given the trends in the employment rate and real GNP and the estimates of the *cyclical* response of employment to output from Table 2 (that is, $b_0^C + b_1^C + b_2^C$), Equation (13) may be used to compute a time-series of the required GNP growth rate. The result of this computation—shown in Chart 5—indicates that the required growth rate has been declining over most of the sample period. This is consistent with the earlier finding that the intercept in the simple Okun's Law equations estimated in Table 1 was higher (less negative) in the 1966–83 period than in the earlier years. However, the employment rate equation in Table 2 implies that if, as expected, real GNP growth increases in the eighties compared to the seventies, the *required* growth rate will also rise. The projec-

Table 2
Trend Equations Under CEA Scenario
(All Variables Are Annual Percentage Growth Rates)

Independent Variables	Dependent Variable				
	Employment Rate	Output Per Worker-Hour	Participation Rate	Actual/ Potential Hours	Potential Hours
Constant	-0.383 (1.47)	-0.341 (0.48)	0.909 (2.34)	-0.072 (0.71)	-0.113 (0.21)
Trend GNP*	-0.296 (2.12)	0.921 (2.44)	-0.403 (1.93)	-0.015 (0.27)	-0.207 (0.73)
Actual GNP (t)	0.252 (11.39)	0.560 (9.38)	0.00 (.002)	0.057 (6.59)	0.131 (2.90)
Actual GNP (t-1)	0.168 (7.08)	-0.188 (2.93)	0.035 (0.98)	-0.0009 (0.10)	-0.014 (0.29)
Actual GNP (t-2)	0.057 (2.63)	-0.070 (1.19)	-0.007 (0.20)	-0.0008 (0.09)	0.020 (0.46)
R^2	0.73	0.42	0.005	0.27	0.045
SEE	0.98	2.64	1.46	0.038	2.00

*Growth rate of trend GNP over preceding three quarters.

Chart 5
Required GNP Growth Rate



tion process used here implicitly allows for this because the required rate varies with the trend rate.

The sums of the four slope coefficients in the equations in Table 2 are estimates of the trend response of each variable to changes in trend GNP (that is, of $b_0^T + b_1^T + b_2^T$). These estimated trend response coefficients, together with the estimated intercept terms, were used to simulate the quarterly trend growth of each variable under each future growth scenario. These projected growth rates were cumulated to yield projections of the trend *levels* of each variable between 1983(IV) and 1990(IV).

We suggested earlier that the supplementary variables might be interdependent so that their *individual* growth rates are not closely related to GNP growth. The results in Table 2 support that argument. Output per worker-hour and the actual/potential hours ratio are related only weakly to GNP, while the participation rate and potential hours show essentially no relation. The fact that the fit of the employment rate (Okun's Law) equation is nonetheless quite close supports the hypothesis that this equation *internalizes* the interdependencies between the supplementary variables.

The second stage in the projection process involves the cyclical components of the series. Equations were estimated in the form of Equation (17) of the relations between the cyclical growth rate of each series and the cyclical growth rate of per capita real GNP. The equations estimated under the CEA growth scenario are shown in Table 3.[19] They

Table 3
Cycle Equations Under CEA Scenario
(All Variables Are Annual Percentage Growth Rates)

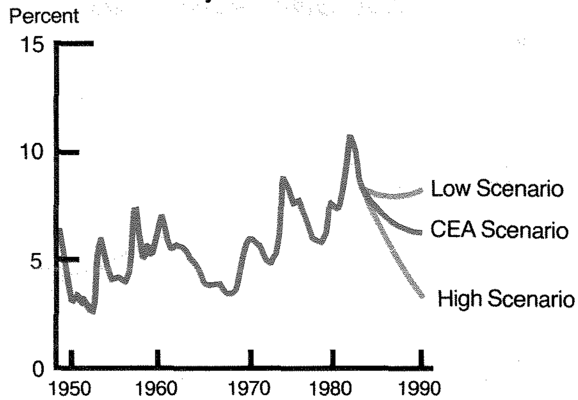
Independent Variables	Dependent Variable				
	Employment Rate	Output Per Worker-Hour	Participation Rate	Actual/ Potential Hours	Potential Hours
Constant	0.045	-0.071	-0.125	-0.026	0.177
	(0.53)	(0.31)	(0.96)	(0.78)	(1.01)
GNP (t)	0.251	0.561	0.001	0.057	0.129
	(11.53)	(9.47)	(0.32)	(6.55)	(2.85)
GNP (t-1)	0.168	-0.189	0.035	-0.0007	-0.14
	(7.19)	(2.97)	(0.97)	(0.07)	(0.28)
GNP (t-2)	0.06	-0.081	-0.005	0.0006	0.024
	(2.80)	(1.38)	(0.14)	(0.07)	(0.55)
R^2	0.74	0.40	0.00	0.27	0.59
SEE	0.30	2.60	1.49	0.39	2.01

were simulated to 1990(IV) to yield projections of the cyclical component of the variables under each growth scenario.[20] The projected cyclical components then were added to the trend projections derived earlier from Table 2 to yield quarterly forecasts of each of the variables over the remainder of the decade.

The resulting projections of the unemployment rate are shown in Chart 6. Unemployment rates of 8.2 percent and 3.2 percent are projected for the end of 1990 under the low and high growth scenarios, and a rate of 6.2 percent is projected under the CEA scenario. The low growth scenario calls for slower economic growth than required to maintain a constant unemployment rate. This implies a rising unemployment rate through the eighties. The CEA scenario implies an unemployment rate by the end of the decade that is close to most economists' estimates of the natural rate. Under the high growth scenario, the unemployment rate is brought significantly below the natural rate. The implication to be drawn from this result, however, is that this scenario, which implies a total GNP growth of almost five percent per year over the remainder of the decade, is unrealistically high. Any attempt to achieve such rapid growth would soon push the economy beyond its inflation threshold.

Chart 6

Unemployment Rate, With Projections to 1990



III. Implications of the Projections

In Table 4, the projections of the unemployment rate developed in the previous section are compared with the annual estimates made by the President's Council of Economic Advisers. Both sets of predictions are based on the same assumed growth in real GNP in the years ahead. Although the estimation methods are different, the two projections are quite close. Both forecasts call for the unemployment rate to average close to six percent by 1989. One difference between the two sets of estimates is that the calculations made in this paper imply that most of the reduction in the unemployment rate will occur in the near future whereas the Council's forecasts show the largest declines in the later years. This reflects the fact that our Okun's Law model implies that the unemployment rate responds more strongly to cyclical changes in GNP growth than to changes in trend and hence shows smaller declines in unemployment as GNP converges on its long-run trend path.

As pointed out in the preceding section, however, the projections are sensitive to the assumptions with regard to real economic growth. The estimates presented in Table 4 are those implied by the CEA growth scenario. Under the low scenario, the unemployment rate is projected to remain essentially unchanged from its late 1983 level. Although most economists expect economic growth over the decade to be more rapid than the rate assumed in that scenario—two percent per annum in per capita terms—it is worth pointing out that that rate is already higher than the growth achieved during the seventies. In other words, simply to hold on to the employment gains achieved since 1982 will require economic growth at rates higher than the U.S. has achieved since the sixties.

In contrast, the high scenario—which calls for per capita growth at a four percent rate—would rapidly bring unemployment down to the natural rate. The projected unemployment rate declines to 5.5 percent by mid-1987 under this scenario. However, such rapid real growth would exceed even that achieved in the early sixties—between 1960(IV) and 1966(IV) real per capita GNP increased at an annual rate of 3.7 percent. Moreover, in that earlier period, inflation and the federal deficit were negligible and, as a consequence, interest rates were significantly lower. Thus, the projections based on this high growth assumption are almost certainly too optimistic. Any attempt to achieve them would likely produce a substantial rise in the inflation rate.

The unemployment projections in Chart 6 and Table 4 used the fourth quarter of 1983 as their base. Since that time, the unemployment rate has declined more rapidly than projected, reaching an average of 7.4 percent in the second quarter of 1984. It is clear, however, that this "miss" occurred because real GNP growth has been greater than assumed in the projections rather than from a defect in the estimation method used. In the first two quarters of 1984, per capita GNP increased at an average annual rate of 7½ percent rather than the 3½ percent assumed in the CEA scenario. This difference in output growth would be expected to reduce the unemployment rate by 0.8 percentage point over two quarters, which is exactly equal to the difference between the actual and projected rates in 1984(II). This gives one some confidence that, if the GNP assumptions underlying the projections prove to be accurate *over the decade as a whole* (that is, that the rapid growth in the first half of 1984 represents "borrowing from the future"), the long-run unemployment projections also will be close to the mark.

Table 4 also compares the projections of output per worker and of labor force participation. Although the Council's estimate of the unemployment rate at decade's end is close to that developed in this paper, the estimates of these supplementary variables are different. The Council predicts more rapid growth in labor force participation and slower expansion in output per worker.

This paper's estimates of productivity and participation are made in the same manner as the employment rate estimates—by simulating the equations estimated in Tables 2 and 3. However, because these simulated values satisfy Equation (1), any *one* of the variables may be regarded as being obtained as a residual. Unfortunately, the fit of the estimated equations was poor. As a result, one has less confidence in the forecast of these supplementary variables than of the employment rate. Nonetheless, their simulated values appear reasonable, and this adds modestly to one's confidence in the unemployment rate projections.

As is well-known, the acceleration in overall labor force participation after about 1965 chiefly reflected the increased number of women choosing

Table 4
Alternative Labor Market Projections: CEA Scenario

				Okun's Law Projections		CEA Projections	
	1975 Level	1983 Level	Annual Percentage Change 1975-83	1989 Level	1983-89 Growth	1989 Level	1983-89 Growth
Real GNP Per Capita ($ 1972)	8041	8812	1.14	10684	3.21	10684	3.21
Civilian Employment Rate (%)	91.5	90.1	-0.19	93.7	0.64	94.2	0.74
Civilian Unemployment Rate (%)	8.5	9.9		6.3		5.8	
Real GNP Per Employed Worker ($ 1972)	14349	15226	0.74	17770	2.58	16900	1.74
Civilian Participation Rate (%)	61.3	64.2	0.75	64.2	0.00	67.0	0.71

Source: **Annual Report** of the President's Council of Economic Advisers, 1984, and author's calculations.

Note: This table shows 1989 annual average projections since this is the last date projected by the Council.

to enter paid employment. By the end of 1983, the female participation rate had reached 53 percent compared to 76 percent for men. It remains an open question whether this increase in women's participation in the work force principally reflects a fundamental cultural change or merely the response of families to a slowing in economic growth. For either explanation, however, one would expect some slowing in overall labor force participation in the years ahead as GNP growth picks up and women's participation approaches that of men. The estimates in Table 4 show such a slowing.

It is widely expected that labor productivity growth will increase in the present decade, especially if overall GNP growth remains strong. Since the output per worker-hour equation in Table 2 implies that productivity growth responds more strongly to a change in the trend of GNP than to its cyclical movements, the growth of productivity would tend to accelerate if real per capita GNP growth of close to three percent a year is in fact achieved for the next several years. The slower growth and increasing experience of the work force also will tend to stimulate productivity growth.

Slower growth of labor force participation makes it easier to bring the unemployment rate down because fewer jobs are needed for new entrants to the labor market. On the other hand, more rapid productivity growth makes it more difficult, since a given growth rate of real GNP generates fewer new jobs. As pointed out earlier, the advantage of invoking Okun's Law is that it enables one to estimate unemployment rates quite well even though the response of productivity growth and labor force growth to alternative paths of real GNP growth are individually difficult to predict. Nonetheless, it is reassuring that estimates of productivity and participation that are consistent with our unemployment rate forecasts also seem to make sense in terms of the factors that appear likely to influence them in the years ahead.

Conclusion

The projections developed in this paper are, at best, illustrative. Clearly, their realization will depend on the path of real GNP attained in the present decade. For example, if the CEA growth projections *are* achieved, the past stability of Okun's Law argues that the unemployment rate is likely to decline much more slowly in the years ahead than it has since the business cycle trough in December 1982. In other words, bringing the unemployment rate down more rapidly—given 3 percent growth in real per capita GNP—would require a *shift* in the historical relation between employment and real growth. Given the past stability of this relation, the probability of such an outcome appears not to be very high. On the other hand, an attempt to bring unemployment down more rapidly by aiming for a rate of per capita growth above three percent would run the risk of over-stimulating the economy and pushing it past its inflation threshold.

1. Arthur M. Okun, "Potential GNP: Its Measurement and Significance," American Statistical Association, **1962 Proceedings of the Business and Economic Statistics Section**, p. 99.

2. For simplicity, the effects of varying hours of work are included in the output per worker variable. In the later empirical calculations, a more complex version of this identity is used.

3. Note that the derivative of the logarithm of any variable z with respect to time is the instantaneous growth rate of z.

4. For example, $\ln(1-u) = 0.1054$ for $u = 0.10$.

5. In a recent paper, Michael Darby attributed much of the recent slowdown in measured productivity growth to these types of changes. See Michael R. Darby, "The U.S. Productivity Slowdown: A Case of Statistical Myopia", **American Economic Review**, Volume 74, Number 3, June 1984.

6. R.L. Brown, J. Durbin, and J.M. Evans, "Techniques for Testing the Constancy of Regression Relationships Over Time," **Royal Statistical Society Journal**, Series B, Vol. 37, No. 2, 1975, p. 157.

7. Gregory C. Chow: "Tests of Equality Between Sets of Coefficients in Two Linear Regressions", **Econometrica**, Vol. 28, No. 3 (July 1960).

8. This statement refers to the equations shown in the fourth and fifth columns of Table 1 in which the intercept values are allowed to shift in 1966(II).

9. The relation between the flows into and out of the unemployment pool and the total number of persons unemployed is explored in detail in a paper by Michael Keely in this issue of the **Economic Review**.

10. These projections are given in Table 6-11 of the **1984 Annual Report** of the Council of Economic Advisers. This table also includes projections of real GNP, total employment and output per hour.

11. See H.N. Fullerton, Jr. and J. Tschetter, "The 1995 Labor Force: A Second Look," **Monthly Labor Review**, Vol. 106, No. 11 (November 1983). The participation rates implied by the CEA's unemployment rate projections correspond to those given in this article.

12. See Curtis L. Gilroy, "Supplemental Measures of Labor Force Utilization", **Monthly Labor Review** (May 1975), for a description of these data.

13. Throughout this discussion the phrase "per capita" means "per head of the civilian adult non-institutional population."

14. **Economic Report of the President**, February 1984, Tables 6-10 and 6-11.

15. That is, regressions were run in the form

$$\ln z_T = a_0 + a_1 T + a_2 T^2 + a_3 T^3 + a_4 T^4,$$

where T is a quarterly time trend variable equal to 1 in 1950(I) and 136 in 1983 (IV) and z_T represents in turn each of the variables in Equation (15). This decomposition method ensures that the "adding up" restrictions implied by Equation (15) also hold for the trend and cycle components individually.

16. This "agnostic" assumption is adopted because one has no way of knowing whether GNP will be above or below trend in 1990(IV); that is, whether that quarter will coincide with an upswing or a downswing in the business cycle.

17. Specifically, for each scenario, a fourth degree polynomial was fitted to per capita GNP from 1950 to 1983, subject to the restriction that it smoothly approached the projected value of actual GNP in 1990 (IV). The fitted values of these polynomials in 1984-90 were designated as the projected future trend of GNP under each scenario. This procedure yielded values of the *past* trend of GNP which were slightly different from those yielded by the unrestricted polynomial regression described in footnote 15. To ensure consistency, the trend values of the employment rate and the supplementary variables in the period 1950-1983 computed from the unrestricted polynomial regressions were adjusted to sum to revised trend GNP under each scenario.

18. The decomposition of GNP into its cycle and trend components is different under each growth scenario (owing to the restriction that the cyclical component goes to zero in 1990 (IV)) and also different when the decomposition is derived only from 1950-83 data without restrictions. However, the coefficients on actual GNP growth are only slightly different in each scenario, implying that the estimated *cyclical* response of employment to GNP is not sensitive to the precise method used to decompose the GNP series into its trend and cycle components. In addition, although the coefficients on the trend growth of GNP (which represent $(b_0^T + b_1^T + b_2^T) - (b_0^C + b_1^C + b_2^C)$ in Equation (18) differed between scenarios, these differences were largely offset by opposite differences in the constant terms (a in Equation (18)). Thus, the estimated values of the *required rate* were very similar in the alternative scenarios.

19. As in the case of the equations in Table II, the coefficients of the equations varied very little between the three scenarios.

20. In making these simulations, the constant term in the equation was deleted. This constant term in principle represents a^C in Equation (17) and thus is incorporated in the intercept in Equation (18) which was used in projecting the trend.